

SOLAR OBSERVATIONS

[Meteorological Research Division, EDGAR W. WOOLARD in charge]

SOLAR RADIATION OBSERVATIONS, MAY 1940

By DAVID HABER

Measurements of solar radiant energy received at the surface of the earth are made at nine stations maintained by the Weather Bureau, and at 10 cooperating stations maintained by other institutions. The intensity of the total radiation from sun and sky on a horizontal surface is continuously recorded (from sunrise to sunset) at all these stations by self-registering instruments; pyrheliometric measurements of the intensity of direct solar radiation at normal incidence are made at frequent intervals on clear days at three Weather Bureau stations (Washington, D. C., Madison, Wis., Lincoln, Nebr.) and at the Blue Hill Observatory at Harvard University. Occasional observations of sky polarization are taken at the Weather Bureau stations at Washington and Madison.

The geographic coordinates of the stations, and descriptions of the instrumental equipment, station exposures, and methods of observation, together with summaries of the data obtained, up to the end of 1936, will be found in the MONTHLY WEATHER REVIEW, December 1937, pp. 415 to 441; further descriptions of instruments and methods are given in Weather Bureau Circular Q.

Table 1 contains the measurements of the intensity of direct solar radiation at normal incidence, with means and their departures from normal (means based on less than 3 values are in parentheses). At Madison and Lincoln the observations are made with the Marvin pyrheliometer; at Washington and Blue Hill they are obtained with a recording thermopile, checked by observations with a Marvin pyrheliometer at Washington and with a Smithsonian silver-disk pyrheliometer at Blue Hill. The table also gives vapor pressures at 7:30 a. m. and at 1:30 p. m. (75th meridian time).

Table 2 contains the average amounts of radiation received daily on a horizontal surface from both sun and sky during each week, then departures from normal and the accumulated departures since the beginning of the year. The values at most of the stations are obtained from the records of the Eppley pyrheliometer recording on either a microammeter or a potentiometer.

Direct solar radiant energy averaged considerably below normal at Washington, Madison, and Blue Hill, while at Lincoln it slightly exceeded the normal amount.

Total solar and sky radiation considerably exceeded the normal amount at New Orleans, Lincoln, Riverside, and Fairbanks, and was somewhat in excess at Fresno. It was decidedly deficient at Blue Hill, Newport, Madison, and Chicago, and somewhat deficient at Ithaca and New York. At Albuquerque the data are missing for the weeks beginning with May 6, 13, and 20, because the pyrheliometer was broken during a hailstorm. The Fairbanks average intensities and departures for April, published as late data, show a considerable excess.

Two skylight polarization measurements made at Madison gave 58 percent on the 20th and 53 percent on the 23d. The normal sky polarization at Madison in May is 57 percent.

TABLE 1.—*Solar radiation intensities during May 1940*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance										Local mean solar time
	7:30 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time	Air mass									
	o	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
May 5	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
May 13	5.56					1.45					5.79
May 18	7.29					1.06					7.29
May 17	7.87				0.91	1.12					7.04
May 18	7.87	0.58	0.69								9.14
May 23	10.21				.91	1.14					8.48
May 29	10.59				.91	1.16					9.47
Means		(.58)	(.69)		.91	1.19					
Departures		-.14	-.15	-.09	-.09						

MADISON, WIS.

May 11	5.56	0.69	0.48	0.60	0.88	1.16					6.02
May 14	9.93	.32	0.48	0.60	0.88	1.16					12.24
May 17	5.79	.48	.60	.81	1.02	1.29					7.04
May 20	8.18			.94	1.14	1.39					8.18
May 23	7.29	.45	.54	.75	1.10	1.36					4.57
May 25	6.76	.61	.71	.88	1.18	1.41					7.87
May 31	10.21	.36	.47	.58	.86	1.10					10.21
Means		.48	.56	.76	1.03	1.28					
Departures		-.15	-.23	-.22	-.08	-.09					

LINCOLN, NEBR.

May 2	3.81					1.50	1.23				3.63
May 9	6.50	0.77	0.85								7.29
May 10	8.18			1.04	1.20	1.42					8.18
May 22	6.27			.96	1.20	1.44					5.56
May 23	7.29			.79	1.02	1.29					4.37
May 27	5.56			1.05	1.22	1.48					6.76
May 28	6.02						1.36				6.50
May 29	7.29		.74	.89	1.11	1.43					7.57
May 31	10.59			.84	1.04	1.39	1.00				11.38
Means		(.77)	(.80)	.93	1.13	1.41	(1.12)				
Departures		+.10	+.01	+.01	+.01	+.03	+.01				

BLUE HILL, MASS.

May 3	10.6					1.35	1.10	0.95	0.82	0.73	10.7
May 6	5.2	0.80	0.89	1.02	1.12						3.2
May 7	5.8					1.20	1.45				4.4
May 8	5.2	.84	.94	1.07	1.22	1.44					2.3
May 9	4.6						1.06	.87	.74	.67	3.6
May 10	3.5	.86	.96	1.08	1.18	1.44					3.2
May 13	3.6	.68	.76	.88	1.02	1.33					3.0
May 14	7.4					.81			.88	.78	7.1
May 15	7.1	.40	.50	.61	.76	.99					6.1
May 18	6.3	.38	.51	.68	.87						6.5
May 19	7.1	.47	.58		.97	1.29	.87	.60			6.3
May 29	7.4					1.38	1.15	.97	.79	.68	7.1
May 30	5.6	.52	.62	.74	.93	1.28	1.01	.83	.69		5.8
Means		.62	.72	.87	1.01	1.33	1.04	.85	.76	.69	
Departures		+.01	-.15	-.17	-.10	-.03	-.05	-.01	-.01	.00	

*Extrapolated.

TABLE 2.—Average daily totals of solar radiation (direct + diffuse) received on a horizontal surface
[Gram-calories per square centimeter]

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Albuquerque	Fairbanks	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Newport	Friday Harbor	Ithaca	Cambridge
	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Apr. 29	467	375	605	318	430	666	772	464	600	528	500	582	386	435	462	365	388
May 6	581	449	562	494	571	685	—	521	555	526	565	618	595	564	519	508	610
May 13	562	370	477	321	464	651	—	432	494	509	556	580	417	474	560	365	478
May 20	313	506	590	358	226	695	—	458	461	495	505	532	209	244	666	453	184
May 27	498	505	636	429	413	701	785	613	598	407	509	584	439	499	576	396	468
DEPARTURES FROM WEEKLY NORMALS																	
Apr. 29	-3	-70	+125	-74	+21	+32	—	+57	+12	+16	+88	+26	-92	-56	-79	-15	—
May 6	+121	-2	+103	+81	+166	+36	—	+63	-11	+11	+144	+66	+89	+45	-35	+87	—
May 13	+77	-107	-41	-102	+39	-16	—	-37	-18	+14	+132	+60	-97	-24	+10	-73	—
May 20	-184	+11	+34	-95	-206	+17	—	+8	-22	-5	+81	-18	-273	-239	+90	-29	—
May 27	-20	+7	+103	-43	-56	+12	—	+157	+56	-56	+24	+28	-122	-45	+18	-60	—
ACCUMULATED DEPARTURES ON JUNE 2																	
	-742	+385	-1,526	-266	+2,590	-1,470	—	+3,115	-1,421	+2,534	+5,124	-2,205	-1,931	-2,359	+2,849	—	—

LATE DATA

The mean daily total solar and sky radiation in gram-calories per square centimeter received on a horizontal surface at Fairbanks for the weeks beginning with April 1, 8, 15, and 22 are, respectively, 352, 390, 356, and 495, with corresponding departures +14, +24, -16, and +121.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory. Data from measurements at the U. S. Naval Observatory from plates obtained at the observatories indicated. Difference in longitude is measured from the central meridian, positive toward the west. Latitude is positive toward the north. Areas are corrected for foreshortening and expressed in millionths of Sun's hemisphere. For each day below longitude, latitude, area of spot or groups, and spot count, are given, respectively, the assumed longitude of the center of the disk, assumed latitude of the center of the disk, total area of spots and groups, and total spot count.]

Date	Eastern standard time	Mount Wilson group No.	Heliographic				Observatory		
			Difference in longitude	Longitude	Latitude	Distance from center of disk	Area of spot or group	Spot count	Plate quality
1940 May 1	h 9 m 5	(*) 6826	° -48	329	-9	48	6	1	G
		(*) 6826	-42	335	+9	44	24	4	
		(*) 6825	-15	2	-8	16	12	1	
		(*) 6824	-9	8	-11	12	6	2	
		6824	+4	21	+9	12	97	7	
		6825	+15	32	-14	19	12	5	
		6818	+86	103	-3	86	97	1	
			(17)	(-4)			254	21	
2 10 46	6827	-35	328	+8	37	6	1	G	Do.
	6826	-30	333	+9	33	24	4		
	(*) 6823	-30	333	-21	34	6	3		
	6824	+18	21	+10	23	48	7		
	6825	+30	33	-13	32	6	1		
		(3)	(-4)				90	16	
3 8 45	6826	-18	333	+9	23	12	1	G	Do.
	6824	+31	22	+10	34	73	12		
	6825	+41	32	-13	42	24	6		
		(351)	(-4)				109	19	
4 9 47	(*) 6827	-44	293	+20	50	6	3	VG	Do.
	6827	-10	327	+10	17	24	5		
	6826	-4	333	+9	14	48	14		
	6824	+45	22	+10	47	24	11		
	6825	+56	33	-13	56	24	4		
		(337)	(-4)				119	37	
5 8 56	6826	+10	334	+9	17	97	22	G	Do.
	6824	+59	23	+10	60	24	4		
		(324)	(-4)				121	26	
6 11 30	6827	+18	327	+12	24	36	4	G	U. S. Naval.
	6826	+23	332	+12	27	206	19		
	(*) 6825	+25	334	-14	26	6	1		
	6828	6	-9	57	57	6	1		
		(309)	(-4)				254	25	
7 11 47	6827	+30	326	+12	33	73	8	VG	Do.
	6826	+37	333	+12	41	194	14		
		(296)	(-3)				207	22	
8 11 20	6830	-51	232	-9	52	36	7	G	Do.
	6829	-25	258	-17	32	48	8		
	6827	+46	329	+12	49	97	15		
	6826	+52	335	+12	54	97	1		
		(283)	(-3)				278	31	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mount Wilson group No.	Heliographic					Area of spot or group	Spot count	Plate quality	Observatory
			Difference in longitude	Longitude	Latitude	Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory	
1940 May 9	h 8 48	6832	-65	206	-8	65	24	1	VG	Mt. Wilson.	
		6830	-37	234	-9	38	48	16			
		6831	0	271	+5	8	12	1			
		(*) 6835	+35	306	-9	36	6	1			
		6827	+60	331	+11	62	97	12			
		6826	+65	336	+11	66	97	5			
							(271)	(-3)			
									284	36	
10 11 23	6832	-51	206	-9	52	145	4		G	U. S. Naval.	
	6830	-23	234	-10	23	121	11				
	6827	+73	330	+11	73	73	1				
	6826	+81	338	+10	81	24	3				
							(257)	(-3)	363	19	
11 11 10	6832	-44	200	-13	46	6	4		G	Do.	
	6832	-38	206	-9	40	339	27				
	6830	-9	235	-12	12	73	8				
	6827	+88	332	+11	88	48	1				
							(244)	(-3)	466	40	
12 12 8	6835	-84	146	+13	84	339	1		F	Do.	
	6835	-90	140	+12	80	97	1				
	6832	-24	206	-7	24	339	14				
	6834	-14	216	-11	16	48	6				
	6830	+6	236	-9	8	97	8				
	6829	+30	260	-18	33	6	1				
	6833	+58	288	-14	60	6	2				
							(230)	(-3)	932	33	
13 11 16	6836	-88	134	+14	83	485	5		VG	Do.	
	6835	-70	147	+13	70	145	1				
	6835	-67	150	+12	67	388	1				
	6832	-11	206	-8	13	291	18				
	6834	-1	216	-10	7	97	9				
	6830	+17	284	-9	18	194	16				
	6833	+72	280	-14	72	48	1				
							(217)	(-3)	1,648	51	
14 11 0	6836	-68	136	+15	68	436	4		G	Do.	
	6835	-58	146	+14	60	194	1				
	6835	-54	150	+13	54	291	2				
	6938	-27	177	+9	30	48	6				
	(*) 17	187	+9	22	24	1					
	6832	+2	206	-8	6	267	10				
	6837	+2	206	-11	9	24	2				
	6834	+11	215	-10	13	85	2				
	6834	+16	220	-11	17	12	2				
	6830	+30	234	-9	31	291	20				
							(204)	(-3)	1,672	50	
15 11 13	6836	-54	137	+15	58	436	6		VG	Do.	
	6835	-44	147	+14	47	194	2				
	6835	-40	151	+12	43	267	1				
	6838	-11	180	+9	16	24	3				
	6832	+16	207	-8	17	255	20				
	6837	+16	207	-11	18	61	11				
	6834	+25	216	-9	25	48	1				
	6830	+44	235	-8	44	194	17				
							(191)	(-3)	1,479	61	